16. Diabetes Care in the Hospital: Standards of Care in Diabetes—2025

*American Diabetes Association Professional Practice Committee**

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Among hospitalized individuals, hyperglycemia, hypoglycemia, and glucose variability are associated with adverse outcomes, including increased morbidity and mortality (1). Identification and careful management of people with diabetes and dysglycemia during hospitalization has direct and immediate benefits. Diabetes management in the inpatient setting is facilitated by identification and treatment of hyperglycemia prior to elective procedures, a dedicated inpatient diabetes management service applying validated standards of care, and a proactive transition plan for outpatient diabetes care with timely scheduled follow-up appointments. These steps can improve outcomes, shorten hospital stays, and reduce the need for readmission and emergency department visits. For older hospitalized individuals or for people with diabetes in long-term care facilities, please see Section 13, "Older Adults."

HOSPITAL CARE DELIVERY STANDARDS

Recommendations

16.1 Perform an A1C test on all people with diabetes or hyperglycemia (random blood glucose >140 mg/dL [>7.8 mmol/L]) admitted to the hospital if no A1C test result is available from the prior 3 months. **B**

16.2 Institutions should implement protocols using validated written or computerized provider order entry sets for management of dysglycemia in the hospital that allow for a personalized approach. **B**

Considerations on Admission

High-quality hospital care for diabetes requires clear and actionable standards for care delivery, which are best implemented using structured order sets and quality improvement strategies for process improvement. Unfortunately, "best practice" protocols,

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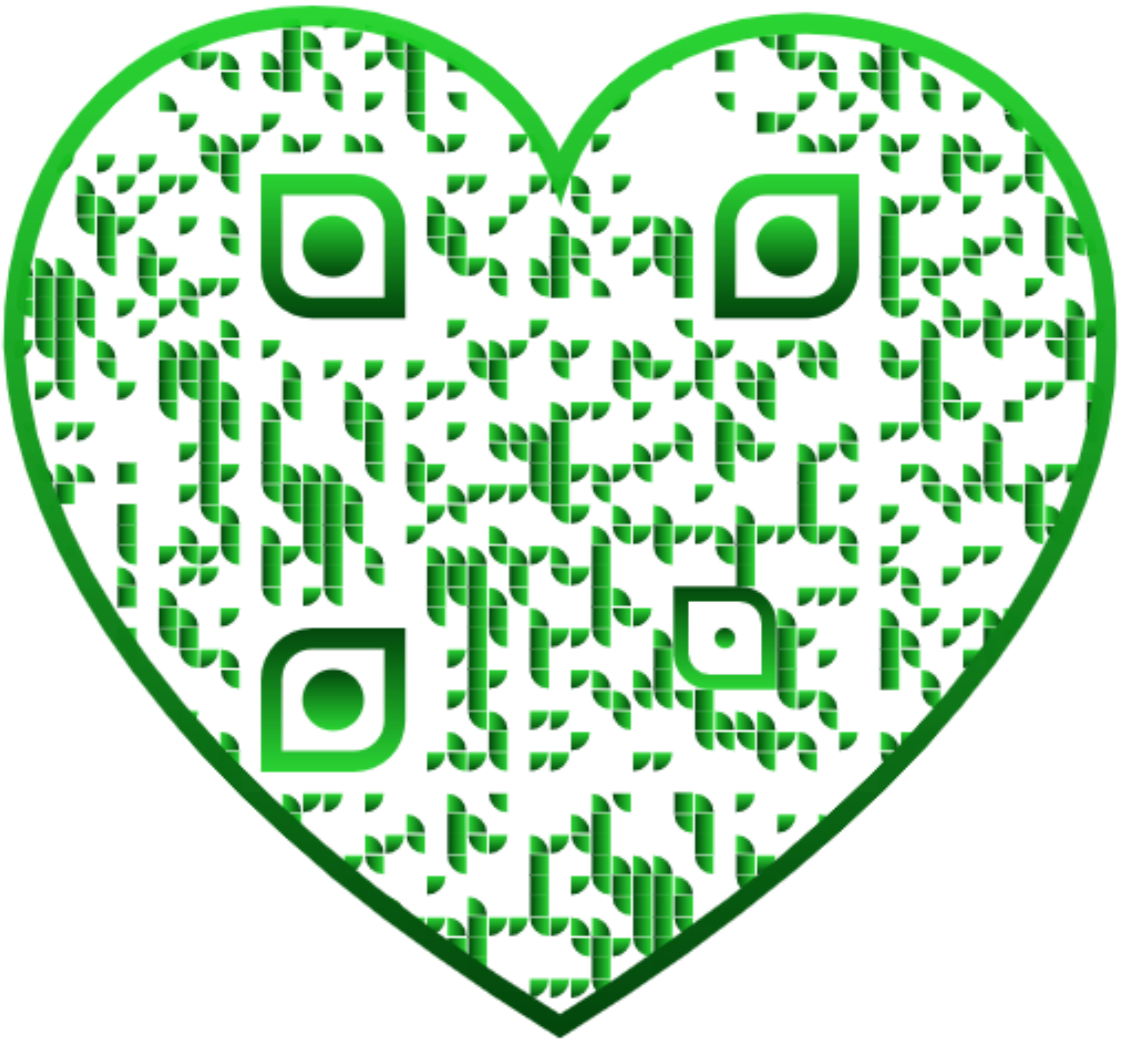

reviews, and guidelines are inconsistently implemented within hospitals (2). To correct this, medical centers striving for optimal inpatient diabetes treatment should establish protocols and structured order sets, which include computerized provider order entry (CPOE). Institutions are encouraged to perform audits regularly to monitor proper use and institute educational/training programs to update staff on an ongoing basis.

Initial evaluation should state the type of diabetes (i.e., type 1, type 2, gestational, pancreatogenic, stress hyperglycemia, drug related, or nutrition related [e.g., enteral or parenteral nutrition]) when it is known. Because inpatient treatment and discharge planning are more effective when preadmission glycemia is considered, A1C should be measured for all people with diabetes or dysglycemia admitted to the hospital if no A1C test result is available from the previous 3 months (3,4). In addition, diabetes self-management knowledge and behaviors should be assessed on admission, and diabetes self-management education should be provided throughout the hospital stay, especially if a new treatment plan is being considered. Diabetes self-management education should include the knowledge and skills needed after discharge, such as medication dosing and administration, glucose monitoring, and recognition and treatment of hypoglycemia (5). Evidence supports preadmission treatment of hyperglycemia in people scheduled for elective surgery as an effective means of reducing adverse outcomes (6,7).

The National Academy of Medicine recommends CPOE to prevent medication-related errors and to increase medication administration efficiency (8). Systematic reviews of randomized controlled trials using computerized assistance to improve glycemic outcomes in the hospital found significant improvement in the percentage of time individuals spent in the glycemic goal range, lower mean blood glucose levels, and no increase in hypoglycemia (9). Where feasible, there should be structured order sets that provide computerized guidance for glycemic management. Insulin dosing algorithms using machine learning and data in the electronic health record (EHR) currently in development show promise for predicting insulin requirements during hospitalization (10,11).

Diabetes Care Specialists in the Hospital

Recommendation

16.3 When caring for hospitalized people with diabetes (with an existing or new diagnosis) or stress hyperglycemia, consult with a specialized diabetes or glucose management team when available. **B**

Care provided by appropriately trained specialists or specialty teams may reduce the length of stay and improve glycemic and other clinical outcomes (12–14). In addition, the increased risk of 30-day readmission following hospitalization that has been attributed to diabetes can be reduced, and costs saved, when inpatient care is provided by a specialized diabetes management team (12,15,16). In a cross-sectional study comparing usual care to specialists reviewing diabetes cases and making recommendations virtually through the EHR, rates of both hyperglycemia and hypoglycemia were reduced by 30–40% (17). Providing diabetes self-management education and developing a diabetes discharge plan that includes continued access to diabetes medications and supplies and ongoing education and support are key strategies to improve long-term outcomes (18,19). Details of diabetes care team composition and other resources are available from the Joint Commission accreditation program for the hospital care of diabetes, the Society of Hospital Medicine workbook, and the Joint British Diabetes Societies (JBDS) for Inpatient Care Group (20–22).

GLYCEMIC GOALS IN HOSPITALIZED ADULTS

Recommendations

16.4a Insulin should be initiated or intensified for treatment of persistent hyperglycemia starting at a threshold of ≥180 mg/dL (≥10.0 mmol/L) (confirmed on two occasions within 24 h) for the majority of critically ill individuals (those in the intensive care unit [ICU]). **A**

16.4b Insulin and/or other glucose-lowering therapies should be initiated or intensified for treatment of persistent hyperglycemia starting at a threshold of ≥180 mg/dL (≥10.0 mmol/L) (confirmed on two occasions within 24 h) for the majority of noncritically ill individuals (those not in the ICU). **B**

16.5a Once therapy is initiated, a glycemic goal of 140–180 mg/dL (7.8–10.0 mmol/L) is recommended for most critically ill individuals (those in the ICU) with hyperglycemia. **A** More stringent individualized glycemic goals may be appropriate for selected critically ill individuals if they can be achieved without significant hypoglycemia. **B**

16.5b For noncritically ill individuals (those not in the ICU), a glycemic goal of 100–180 mg/dL (5.6-10.0 mmol/L) is recommended if it can be achieved without significant hypoglycemia. **B**

Standard Definitions of Glucose Abnormalities

Hyperglycemia in hospitalized individuals is defined as blood glucose levels >140 mg/dL (>7.8 mmol/L) (23). An admission A1C value ≥6.5% (≥48 mmol/mol) suggests that the onset of diabetes preceded hospitalization (see Section 2, "Diagnosis and Classification of Diabetes"). Level 1 hypoglycemia is defined as a glucose concentration of 54–69 mg/dL (3.0–3.8 mmol/L). Level 2 hypoglycemia is defined as a glucose concentration <54 mg/dL (<3.0 mmol/L), which is typically the threshold for neuroglycopenic symptoms. Level 3 hypoglycemia is defined as a clinical event characterized by altered mental and/or physical functioning that requires assistance from another person for recovery (**Table 6.4**) (24,25). Levels 2 and 3 require immediate intervention and correction of low blood glucose. Prompt treatment of level 1 hypoglycemia is recommended for prevention of progression to more significant level 2 and level 3 hypoglycemia.

Glycemic Goals

In a landmark clinical trial conducted in a surgical intensive care unit (ICU), Van den Berghe et al. (26) demonstrated that an intensive intravenous insulin protocol with a glycemic goal of 80–110 mg/dL (4.4–6.1 mmol/L) reduced mortality by 40% compared with a standard approach of a glycemic goal of 180–215 mg/dL (10–12 mmol/L) in critically ill hospitalized individuals with diabetes and/or stress hyperglycemia and recent surgery. This study provided evidence that active treatment to lower blood glucose in hospitalized

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individuals could have immediate benefits. However, several multicenter studies, including the Normoglycemia in Intensive Care Evaluation and Survival Using Glucose Algorithm Regulation (NICE-SUGAR) trial, in critically ill hospitalized individuals in medical and surgical ICUs (27–29) led to a reconsideration of the optimal glucose lowering goal in critical illness. In these trials, critically ill individuals randomized to intensive glycemic management (80–110 mg/dL [4.4–6.1 mmol/L]) derived no significant treatment advantage compared with a group with more moderate glycemic goals (140–180 mg/dL [7.8–10.0 mmol/L]) and had slightly but significantly higher mortality (27.5% vs. 25%). The intensively treated group had 10- to 15-fold greater rates of hypoglycemia, which may have contributed to the adverse outcomes noted. The findings from the NICE-SUGAR trial, supported by several meta-analyses and a randomized controlled trial, showed higher rates of hypoglycemia and an increase in mortality with more aggressive glycemic management goals compared with moderate glycemic goals (27,30,31). Based on these results, insulin and/or other therapies should be initiated for the treatment of persistent hyperglycemia ≥180 mg/dL (≥10.0 mmol/L). Once therapy is initiated, a glycemic goal of 140–180 mg/dL (7.8–10.0 mmol/L) is recommended for most critically ill individuals with hyperglycemia. Although not as well supported by data from randomized controlled trials, these recommendations have been extended to hospitalized individuals without critical illness. More stringent glycemic goals, such as 110–140 mg/dL (6.1–7.8 mmol/L), may be appropriate for selected individuals (e.g., critically ill individuals undergoing cardiac surgery) if they can be achieved without significant hypoglycemia (32,33).

For inpatient management of hyperglycemia in noncritical care settings, a glycemic goal of 100–180 mg/dL (5.6–10.0 mmol/L) is recommended, whether it is hyperglycemia due to newly diagnosed diabetes or stress hyperglycemia or hyperglycemia related to diabetes prior to admission (34). It has been found that fasting glucose levels <100 mg/dL (<5.6 mmol/L) are predictors of hypoglycemia within the next 24 h (35). Glycemic levels up to 250 mg/dL (13.9 mmol/L) may be acceptable in selected populations (terminally ill individuals with short life expectancy, advanced kidney failure [and/or on dialysis], high risk for hypoglycemia, and/or labile glycemic excursions). In these individuals, less aggressive treatment goals that would help avoid symptomatic hypoglycemia and/or hyperglycemia are often appropriate. Clinical judgment combined with ongoing assessment of clinical status, including changes in the trajectory of glucose measures, illness severity, nutritional status, or concomitant medications that might affect glucose levels (e.g., glucocorticoids), may be incorporated into the day-to-day decisions regarding treatment goals.

GLUCOSE MONITORING

In hospitalized individuals with diabetes who are eating, point-of-care (POC) blood glucose monitoring should be performed before meals; in those not eating, glucose monitoring is advised every 4–6 h (34). More frequent POC blood glucose monitoring ranging from every 30 min to every 2 h is the required standard for safe use of intravenous insulin therapy.

Hospital blood glucose monitoring should be performed with U.S. Food and Drug Administration (FDA)-approved POC hospital-calibrated glucose monitoring systems (36). POC blood glucose meters are not as accurate or as precise as laboratory glucose analyzers, and capillary blood glucose readings are subject to artifacts due to perfusion, edema, anemia/erythrocytosis, and several medications commonly used in the hospital (36) (**Table 7.1**). The FDA has established standards for capillary (finger-stick) POC glucose monitoring in the hospital (36). The balance between analytic requirements (e.g., accuracy, precision, and interference) and clinical requirements (e.g., rapidity, simplicity, and POC) has not been uniformly resolved (36–39), and most hospitals have arrived at their own policies to balance these parameters. It is critically important that devices selected for in-hospital use, and the workflow through which they are applied, undergo careful analysis of performance and reliability and ongoing quality assessments (39). Recent studies indicate that POC measures provide adequate information for usual practice, with only rare instances where care has been compromised (37,38). Best practice dictates that any glucose result that does not correlate with the individual's clinical status should be confirmed by repeating the test first and measuring a sample in the clinical laboratory if the second result is similar, particularly for asymptomatic hypoglycemic events.

Continuous Glucose Monitoring

Recommendations

16.6 In people with diabetes using a personal continuous glucose monitoring (CGM) device, the use of CGM should be continued during hospitalization if clinically appropriate, with confirmatory point-of-care (POC) blood glucose measurements for insulin dosing decisions and hypoglycemia assessment, if resources and training are available, and according to an institutional protocol. **B**

16.7 Continue use of insulin pump or automated insulin delivery in people with diabetes who are hospitalized when clinically appropriate, with confirmatory POC blood glucose measurements for insulin dosing decisions and hypoglycemia assessment and treatment. This is contingent upon availability of necessary supplies, resources, and training, ongoing competency assessments, and implementation of institutional diabetes technology protocols. **C**

Several studies have demonstrated that inpatient use of continuous glucose monitoring (CGM) has advantages over POC glucose monitoring in detecting hypoglycemia, particularly nocturnal, prolonged and/or asymptomatic hypoglycemia (40–42), and in reducing recurrent hypoglycemia (43,44). However, at this time, initiating use of a new CGM device has not been approved by the FDA. During the coronavirus disease 2019 (COVID-19) pandemic, many institutions used CGM in ICU and non-ICU settings, with the aim of minimizing exposure time and saving personal protective equipment, under an FDA policy of enforcement discretion (45,46). Data on the safety and efficacy of real-time CGM use in the hospital, particularly with implementation of remote monitoring (e.g., a glucose telemetry system), is growing (44,46–49).

Continuation of personal CGM device use, particularly for people with type 1 or type 2 diabetes treated with intensive insulin therapy and at increased risk for hypoglycemia during hospitalization, is recommended. Confirmatory POC capillary

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glucose monitoring, using hospital-calibrated glucose meters, is recommended for insulin dosing and hypoglycemia assessment (e.g., hybrid testing protocols) (42,46,50). People with diabetes should be counseled about meaningful use of trend arrows and alarms and the importance of notifying nursing staff for confirmation of these events with POC capillary glucose monitoring. Similarly, continuation of automated insulin delivery systems should be supported during hospitalization, when clinically appropriate, and with proper staff training and supervision (42,46). Observational studies have demonstrated improvements in patient satisfaction and improved detection of glycemic excursions (41,48). Consultation with the endocrinology/diabetes care team or diabetes care and education specialists, if available, is recommended, especially if the reason for admission is suspected to be related to device malfunction or lack of adequate education/training or use. Hospitals are encouraged to develop institutional policies and have the availability of trained personnel with knowledge of diabetes technology. Recent review articles provide details on accuracy, interferences, precautions, and contraindications of diabetes technology devices in the hospital setting (49,51).

For more information on CGM, see Section 7, "Diabetes Technology."

GLUCOSE-LOWERING TREATMENT IN HOSPITALIZED INDIVDIUALS

An individualized approach for glycemic management is encouraged throughout the hospital stay and should take into consideration several predictive factors for achieving glycemic goals, such as prior home use and doses of insulin or noninsulin therapy, expected level of insulin resistance, prior A1C, current glucose levels, oral intake, and duration of diabetes.

Insulin Therapy

Recommendations

16.8a Continuous intravenous insulin infusion is recommended for achieving glycemic goals and avoiding hypoglycemia in critically ill individuals. **A**

16.8b Basal insulin or a basal plus bolus correction insulin plan is the preferred treatment for noncritically ill hospitalized individuals with poor or no oral intake. **A**

16.9 An insulin plan with basal, prandial, and correction components is the preferred treatment for most noncritically ill hospitalized individuals with adequate nutritional intake. **A**

16.10 For most individuals, sole use of a correction or supplemental insulin without basal insulin (formerly referred to as a sliding scale) in the inpatient setting is discouraged. **A**

Critical Care Setting

Continuous intravenous insulin infusion is the most effective method for achieving specific glycemic goals and avoiding hypoglycemia in the critical care setting. Intravenous insulin infusions should be administered using validated written or computerized protocols that allow for predefined adjustments in the insulin infusion rate based on glycemic fluctuations and immediate past and current insulin infusion rates (52). For diabetic ketoacidosis (DKA) and hyperglycemic hyperosmolar state (HHS) management, continuous intravenous insulin infusion is given for correction of hyperglycemia, hyperketonemia, and acid-base disorder following a fixed-rate intravenous insulin infusion (53) or nurse-driven protocol with a variable rate based on glucose values (54). Individuals with mild and uncomplicated DKA can be managed with subcutaneous rapid-acting insulin doses given every 1–2 h (55).

Noncritical Care Setting

In most instances, insulin is the preferred treatment for hyperglycemia in hospitalized individuals. In certain circumstances, it may be appropriate to continue home oral glucose-lowering medications or initiate use of agents such as dipeptidyl peptidase 4 inhibitors (DPP-4i) (2,50). Several reports indicate that inpatient use of insulin pens is safe and may improve nurse satisfaction when safety protocols, including nursing education, are in place to guarantee single-person use (56–58).

Outside of critical care units, scheduled subcutaneous insulin orders are recommended for the management of hyperglycemia in people with diabetes and hyperglycemia. Use of insulin analogs or human insulin results in similar glycemic outcomes in the hospital setting, but regular insulin may increase the risk of hypoglycemic events (59). The use of subcutaneous rapid- or short-acting insulin before meals, or every 4–6 h if no meals are given or if the individual is receiving continuous enteral or parenteral nutrition, is indicated to correct or prevent hyperglycemia. Basal insulin, or a basal plus bolus correction schedule, is the preferred treatment for noncritically ill hospitalized individuals with inadequate or restricted oral intake. An insulin schedule with basal, prandial, and correction components is the preferred treatment for most noncritically ill hospitalized people with diabetes with adequate nutritional intake.

A randomized controlled trial has shown that basal plus bolus treatment improved glycemic outcomes and reduced hospital complications compared with a correction or supplemental insulin without basal insulin (formerly known as sliding scale) for people with type 2 diabetes admitted for general surgery (60). Prolonged use of correction or supplemental insulin without basal insulin is strongly discouraged in the inpatient setting, with the exception of that for people with type 2 diabetes in noncritical care with mild hyperglycemia or stress hyperglycemia (61,62).

A prospective randomized inpatient study of 70/30 intermediate-acting (NPH)/regular insulin mixture versus basal-bolus therapy showed comparable glycemic outcomes but significantly increased hypoglycemia in the group receiving the insulin mixture (63). Therefore, insulin mixtures such as 75/25, 70/30, or 50/50 insulins are not routinely recommended for in-hospital use.

Data on the use of glargine U-300 and degludec U-100 or U-200 in the inpatient and perioperative settings are limited. A few studies have shown that they demonstrated similar efficacy and safety compared with glargine U-100 (64–66).

Type 1 Diabetes

For people with type 1 diabetes, dosing insulin based solely on premeal glucose levels does not account for basal insulin requirements or caloric intake and increases the risk of both hypoglycemia and hyperglycemia (67). Typically, basal insulin dosing is based on body weight and expected sensitivity to insulin, and there is some evidence that people with renal insufficiency should be treated with lower insulin doses (68,69). An insulin schedule with basal and correction components is necessary for all hospitalized individuals with type 1 diabetes, even for those

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taking nothing by mouth, with the addition of prandial insulin when individuals are eating. Policies and best practice alerts in the EHR should be put in place to ensure that basal insulin (given subcutaneously, via insulin pump or by insulin infusion) is not held for people with type 1 diabetes, especially during care transitions, and that ongoing prescriber and nursing education is provided (57).

Transitioning From Intravenous to Subcutaneous Insulin

When discontinuing intravenous insulin, a transition protocol is recommended, as it is associated with less morbidity and lower costs. Subcutaneous basal insulin should be given 2 h before intravenous infusion is discontinued, with the aim of minimizing rebound hyperglycemia while the subcutaneous insulin action rises (70,71).

Emerging data from studies in people with hyperglycemia with and without DKA show that the administration of a low dose (0.15–0.3 units/kg) of basal insulin analog in addition to intravenous insulin infusion may reduce the duration of insulin infusion and length of hospital stay and prevent rebound hyperglycemia without increased risk of hypoglycemia (72–74).

For transitioning, the total daily dose of subcutaneous insulin may be calculated based on the insulin infusion rate during the prior 6–8 h when stable glycemic goals were achieved, based on prior home insulin dose, or following a weight-based approach (70). For people being transitioned to concentrated insulin (U-200, U-300, or U-500) in the inpatient setting, it is important to ensure correct dosing by using a separate insulin pen or vial for each individual and by meticulous pharmacy and nursing supervision of the dose administered (64–66,75).

Noninsulin Therapies

Recommendation

16.11 For people with type 2 diabetes hospitalized with heart failure, it is recommended that use of a sodium–glucose cotransporter 2 inhibitor be initiated or continued during hospitalization and upon discharge, if there are no contraindications and after recovery from the acute illness. **A**

The safety and efficacy of noninsulin glucose-lowering therapies in the hospital setting has recently expanded (2,50, 76–78). A randomized trial and an observational study have demonstrated the safety and efficacy of DPP-4i in specific groups of hospitalized people with diabetes (79,80). The use of DPP-4i with or without basal insulin may be a safer and simpler plan for people with mild to moderate hyperglycemia on admission (e.g., admission glucose <180–200 mg/dL), with reduced risk of hypoglycemia (2,80,81). However, the FDA states that health care professionals should consider discontinuing saxagliptin and alogliptin in people who develop heart failure (82). Data on the inpatient use of glucagon-like peptide 1 receptor agonists (GLP-1 RAs) are still mostly limited to research studies and select populations that are medically stable (77,78).

For people with type 2 diabetes hospitalized with heart failure, it is recommended that use of a sodium–glucose cotransporter 2 (SGLT2) inhibitor be initiated or continued during hospitalization and upon discharge, if there are no contraindications and after recovery from the acute illness (83,84). SGLT2 inhibitors should be avoided in cases of severe illness, in people with ketonemia or ketonuria, and during prolonged fasting and surgical procedures (85–88). Proactive adjustment of diuretic dosing is recommended during hospitalization and/or discharge, especially in collaboration with a cardiology/heart failure consult team (85–88). It is recommended that SGLT2 inhibitors should be stopped 3 days before scheduled surgeries (4 days for ertugliflozin) (89).

HYPOGLYCEMIA

Recommendations

16.12 A hypoglycemia management surveillance protocol should be adopted by all health systems. A plan for identifying, treating, and preventing hypoglycemia should be established for each individual. Episodes of hypoglycemia in the hospital should be documented in the health record and tracked to inform quality improvements. **C**

16.13 Treatment plans should be reviewed and changed as necessary to prevent hypoglycemia and recurrent hypoglycemia when a blood glucose value of <70 mg/dL (<3.9 mmol/L) is documented. **C**

People with or without diabetes may experience hypoglycemia in the hospital setting. While hypoglycemia is associated with increased mortality (90,91), in many cases, it is a marker of an underlying disease rather than the cause of fatality. However, hypoglycemia is a severe consequence of dysregulated metabolism and/or diabetes treatment, and it is imperative that it be minimized during hospitalization. Many episodes of inpatient hypoglycemia are preventable. A hypoglycemia prevention and management protocol should be adopted and implemented by each hospital or hospital system. A standardized hospital-wide, nurse-initiated hypoglycemia treatment protocol should be in place to immediately address blood glucose levels <70 mg/dL (<3.9 mmol/L) (92,93). In addition, individualized plans for preventing and treating hypoglycemia for each person should also be developed. An American Diabetes Association (ADA) consensus statement recommends that an individual's treatment plan be reviewed any time a blood glucose value of <70 mg/dL (<3.9 mmol/L) occurs, as this level often predicts subsequent level 3 hypoglycemia (94). Episodes of hypoglycemia in the hospital should be documented in the EHR and tracked (1). A key strategy is embedding hypoglycemia treatment into all insulin and insulin infusion orders.

Inpatient Hypoglycemia: Risk Factors, Treatment, and Prevention

Insulin is one of the most common medications that causes adverse events in hospitalized individuals. Errors in insulin dosing, missed doses, and/or administration errors including incorrect insulin type and/or timing of dose occur relatively frequently (95–97) and include prescriber (ordering), pharmacy (dispensing), and nursing (administration) errors. Common preventable sources of iatrogenic hypoglycemia are improper prescribing of other glucose-lowering medications and inappropriate management and follow-up of the first episode of hypoglycemia (34). Kidney failure is an important risk factor for hypoglycemia in the hospital (98), possibly as a result of decreased insulin clearance. Studies of "bundled" preventive therapies, including proactive surveillance of glycemic outliers and an interprofessional data-driven approach to glycemic management, showed that hypoglycemic episodes in the hospital could be reduced

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or prevented. Compared with baseline, studies found that hypoglycemic events decreased by 56–80% (93,99,100). The Joint Commission, a global quality improvement and patient safety in health care organization, recommends that all hypoglycemic episodes be evaluated for a root cause and the episodes be aggregated and reviewed to address systemic issues and possible solutions (21).

In addition to errors with insulin treatment, iatrogenic hypoglycemia may occur after a sudden reduction of corticosteroid dose, reduced oral intake, emesis, inappropriate timing of short- or rapid-acting insulin doses in relation to meals, reduced infusion rate of intravenous dextrose, unexpected interruption of enteral or parenteral feedings, delayed or missed blood glucose checks, and altered ability of the individual to report symptoms (101).

Recent inpatient studies show promise for CGM to alert of impending hypoglycemia, offering an opportunity to mitigate it before it happens (42,46,48). The use of personal CGM and automated insulin delivery devices, such as insulin pumps that can automatically deliver correction doses and change basal delivery rates in real time, should be supported for ongoing use during hospitalization for individuals who are capable of operating their devices safely and independently when proper oversight supervision is available. Hospitals should be encouraged to develop policies and protocols to support inpatient use of individual- and hospital-owned diabetes technology and have expert staff available for safe implementation and evaluation of continued use during the hospital stay (51). Hospital information technology teams are beginning to integrate CGM data into the EHR. The ability to download and interpret diabetes device data during hospitalization can inform insulin dosing during hospitalization and care transitions (42).

For more information on CGM, see Section 7, "Diabetes Technology."

Predicting and Preventing Hypoglycemia

In people with diabetes, it is well established that an episode of severe hypoglycemia increases the risk for a subsequent event, partly because of impaired counterregulation (102). In a study of hospitalized individuals, 84% of people who had an episode of severe hypoglycemia (defined as <40 mg/dL [<2.2 mmol/L]) had a preceding episode of hypoglycemia (<70 mg/dL [<3.9 mmol/L]) during the same admission (103). In another study of hypoglycemic episodes (defined as <50 mg/dL [<2.8 mmol/L]), 78% of individuals were taking basal insulin, with the incidence of hypoglycemia peaking between midnight and 6:00 A.M. Despite recognition of hypoglycemia, 75% of individuals did not have their dose of basal insulin changed before the next basal insulin administration (104). Several groups have developed algorithms to predict episodes of hypoglycemia in the inpatient setting (105,106). Models such as these are potentially important and, once validated for general use, could provide a valuable tool to reduce rates of hypoglycemia in the hospital. In one retrospective cohort study, a fasting blood glucose of <100 mg/dL was shown to be a predictor of next-day hypoglycemia (35).

MEDICAL NUTRITION THERAPY IN THE HOSPITAL

The goals of medical nutrition therapy in the hospital are to provide adequate calories to meet metabolic demands, optimize glycemic outcomes, address personal food preferences, and facilitate the creation of a discharge plan. The ADA does not endorse any single meal plan or specified percentages of macronutrients. Current nutrition recommendations advise individualization based on treatment goals, physiological parameters, and medication use. Controlled carbohydrate meal plans, where the amount of carbohydrate on each meal tray is calculated, are preferred by many hospitals, as they facilitate matching the prandial insulin dose to the amount of carbohydrate given (107). Orders should also indicate that the meal delivery and nutritional insulin coverage should be coordinated, as their variability often creates the possibility of hyperglycemic and hypoglycemic events (18). Some hospitals offer "meals on demand," where individuals may order meals from the menu at any time during the day. This option improves patient satisfaction but complicates glucose monitoring–insulin–meal coordination and can lead to insulin stacking if meals are too close together. Finally, if the hospital food service supports carbohydrate counting, this option should be made available to people with diabetes counting carbohydrates at home, especially people wearing insulin pumps (108,109).

SELF-MANAGEMENT IN THE HOSPITAL

Diabetes self-management in the hospital may be appropriate for select individuals who wish to continue to perform self-care while acutely ill (110–112). Candidates include children with parental supervision, adolescents, and adults who successfully perform diabetes self-management at home and whose cognitive and physical skills needed to successfully self-administer insulin and perform glucose monitoring are not compromised (5,42). In addition, they should have adequate oral intake, be proficient in carbohydrate estimation, take multiple daily insulin injections or wear insulin pumps, have stable insulin requirements, and understand sick-day management. If self-management is supported, a policy should include a requirement that people with diabetes and the care team agree on a daily basis during hospitalization that self-management is appropriate. Hospital personal medication policies may include guidance for people with diabetes who wish to take their own or hospital-dispensed insulin and noninsulin injectable medications during their hospital stay. A hospital policy for personal medication may include a pharmacy exception on a case-by-case basis as determined in consultation with the care team. Pharmacy must verify any home medication and require a prescriber order for the individual to self-administer home or hospital-dispensed medication under the supervision of the registered nurse. If an insulin pump or CGM device is worn, hospital policy and procedures delineating guidelines for wearing an insulin pump and/or CGM device should be developed according to consensus guidelines, including the changing of insulin infusion sites and CGM glucose sensors (42,113). As outlined in Recommendations 7.31 and 7.32, people with diabetes wearing diabetes devices should be supported to continue them in an inpatient setting if they are assessed and deemed competent to perform self-care and proper supervision is available.

STANDARDS FOR SPECIAL SITUATIONS

Enteral and Parenteral Feedings

For individuals receiving enteral or parenteral nutrition who require insulin,

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the insulin orders should include coverage of basal, prandial, and correctional needs (108,114,115). It is essential that people with type 1 diabetes continue to receive basal insulin even if feedings are discontinued.

Most adults receiving basal insulin should continue with their basal dose, while the insulin dose for the total daily nutritional component may be calculated as 1 unit of insulin for every 10–15 g of carbohydrate in the enteral and parenteral formulas. Commercially available cans of enteral nutrition contain variable amounts of carbohydrates and may be infused at different rates (109).

All of this must be considered when calculating insulin doses to cover the nutritional component of enteral nutrition (109). Giving NPH insulin two or three times daily (every 8 or 12 h) or regular insulin every 6 h to cover individual requirements are reasonable options. Adjustments in insulin doses should be made frequently. Correctional insulin should also be administered subcutaneously every 6 h with regular human insulin or rapid-acting insulin every 4 h. If enteral nutrition is interrupted, a dextrose infusion should be started immediately to prevent hypoglycemia and to allow time to determine more appropriate insulin doses.

For adults receiving enteral bolus feedings, approximately 1 unit of regular human insulin or rapid-acting insulin per every 10–15 g of carbohydrate should be given subcutaneously before each feeding. To mitigate any hyperglycemia, correctional insulin should be added as needed before each feeding.

In individuals receiving nocturnal tube feeding, NPH insulin administered along with the initiation of the feeding to cover this nutritional load is a reasonable approach.

For individuals receiving continuous peripheral or central parenteral nutrition, human regular insulin may be added to the solution, particularly if >20 units of correctional insulin have been required in the past 24 h. A starting dose of 1 unit of regular human insulin for every 10 g of dextrose has been recommended (1,108) and should be adjusted daily in the solution. Adding insulin to the parenteral nutrition bag is the safest way to prevent hypoglycemia if the parenteral nutrition is stopped or interrupted. Correctional insulin should be administered subcutaneously to address any hyperglycemia.

Because continuous enteral or parenteral nutrition results in a continuous postprandial state, efforts to bring blood glucose levels to below 140 mg/dL (7.8 mmol/L) substantially increase the risk of hypoglycemia in these individuals. For full enteral and parenteral feeding guidance, please refer to randomized controlled trials detailing this topic (114,116,117).

Glucocorticoid Therapy

The prevalence of consistent use of glucocorticoid therapy in hospitalized individuals can approach 10–15%, and these medications can induce hyperglycemia in 56–86% of these individuals with and without preexisting diabetes (118,119). If left untreated, this hyperglycemia increases mortality and morbidity risk, e.g., infections and cardiovascular events. Glucocorticoid type and duration of action must be considered in determining appropriate insulin treatments. Daily-ingested intermediate-acting glucocorticoids such as prednisone reach peak plasma levels in 4–6 h (120) but have pharmacologic actions that can last throughout the day. When monitored by CGM, the typical glycemic pattern for individuals treated with daily prednisone or prednisolone, administered in the morning, is characterized by normal or mild fasting hyperglycemia, with trends of increasing hyperglycemia during the afternoon, and peaking in the evening. These hyperglycemic excursions are more pronounced in individuals with type 2 diabetes than in those without diabetes (121).

For individuals treated with once- or twice-daily steroids, administering NPH insulin with prednisone or prednisolone dosing is a standard approach, aimed at matching the NPH actions with the steroid-induced hyperglycemic response. NPH may be administered in addition to daily basal-bolus insulin or in addition to oral glucose-lowering medications, depending on the type of diabetes and recent diabetes medication prior to starting steroids (122). Because NPH action peaks about 4–6 h after administration, it is recommended that it be administered concomitantly with intermediate-acting steroids (123). For long-acting glucocorticoids such as dexamethasone and multidose or continuous glucocorticoid use, long-acting basal insulin may be required to manage fasting blood glucose levels (50). For higher doses of glucocorticoids, increasing doses of prandial (if eating) and correction insulin, sometimes as much as 40–60% or more, are often needed in addition to basal insulin (124,125). A retrospective study found that increasing the ratio of insulin to steroids was positively associated with improved time in range (70–180 mg/dL [3.9–10.0 mmol/L]); however, there was an increase in hypoglycemia (118). If insulin orders are initiated, daily adjustments based on levels of glycemia and anticipated changes in type, dosages, and duration of glucocorticoids, along with POC blood glucose monitoring, are critical to reducing hypoglycemia and hyperglycemia.

Perioperative Care

It is estimated that up to 20% of individuals undergoing general surgery have diabetes, and 23–60% have prediabetes or undiagnosed diabetes. Surgical stress and counterregulatory hormone release increase the risk of hyperglycemia as well as mortality, infection, and length of stay (109,126,127). There is little data available to guide care of people with diabetes through the perioperative period. To reduce surgical risk in these individuals, some institutions (126,128,129) have A1C cutoffs for elective surgeries, and some have developed optimization programs to lower A1C prior to surgery (126,128–130).

The following approaches (126,128,130) may be considered:

1. A preoperative risk assessment should be performed for people with diabetes who are at high risk for ischemic heart disease and those with autonomic neuropathy or renal failure.
2. The A1C goal for elective surgeries should be <8% (<64.0 mmol/L) whenever possible.
3. The blood glucose goal in the perioperative period should be 100–180 mg/dL (5.6–10.0 mmol/L) (126) within 4 h of the surgery. CGM should not be used alone for glucose monitoring during surgery (129).
4. Metformin should be held on the day of surgery.
5. SGLT2 inhibitors should be discontinued 3–4 days before surgery.
6. Other oral glucose-lowering agents should be held the morning of surgery or procedure.
7. Insulin dose reductions include NPH insulin to one-half of the dose or long-acting basal insulin analogs

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to 75–80% of the dose or adjustment of insulin pump (if not in automated mode) basal rates based on the type of diabetes and clinical judgment (see Section 7, "Diabetes Technology").
8. Monitor blood glucose at least every 2–4 h while the individual takes nothing by mouth and administer short- or rapid-acting insulin as needed.
9. Stricter peioperative glycemic goals are not advised, as perioperative glycemic goals stricter than 80–180 mg/dL (4.4–10.0 mmol/L) may not improve outcomes and are associated with increased hypoglycemia (128).
10. Compared with usual dosing, a reduction of 25% of basal insulin dose given the evening before surgery is more likely to achieve perioperative blood glucose goals with a lower risk for hypoglycemia (131).
11. In individuals undergoing noncardiac general surgery, basal insulin plus premeal short- or rapid-acting insulin (basal-bolus) coverage has been associated with improved glycemic outcomes and lower rates of perioperative complications compared with the reactive, correction-only short- or rapid-acting insulin coverage alone with no basal insulin dosing (60,126).
12. There is little data on the safe use and/or influence of GLP-1 RAs on glycemia and delayed gastric emptying in the perioperative period. With increasing use of GLP-1 RA and dual glucose-dependent insulinotropic polypeptide (GIP) and GLP-1 RA medications for diabetes and/or weight loss, there are concerns about the safety of these drugs in the perioperative period. These drugs may be associated with nausea, vomiting, and delayed gastric emptying and have the potential to increase the risk of pulmonary aspiration during general anesthesia and deep sedation. The American Society of Anesthesiologists recommends holding GLP-1 RAs on the day of the procedure or surgery for daily dose agents and for at least 7 days prior to the procedures or surgery for once-weekly dose agents (132).

Despite the safety concerns around the use of GLP-1 RA and dual GIP and GLP-1 RA drugs in the perioperative setting, there is a need for guidance for individual risk assessment and mitigation strategies. While waiting for more definitive evidence, an interprofessional and personalized approach for perioperative management of individuals taking a GLP-1 RA or a dual GIP and GLP-1 RA is suggested. Factors such as the primary indication of these medications (e.g., diabetes or weight loss), current glycemic management, type of surgery or procedure and its urgency, type of anesthesia, consideration of preoperative gastric ultrasound to quantify gastric contents, and implementation of full stomach precautions will determine an individualized approach based on clinical judgement. If worsening of glycemic outcomes due to holding a GLP-1 RA or a dual GIP and GLP-1 RA is anticipated, an alternative strategy for perioperative glycemic management (e.g., insulin) should be considered.

Diabetic Ketoacidosis and Hyperglycemic Hyperosmolar State

Recommendations

16.14 Manage diabetic ketoacidosis (DKA) and hyperglycemic hyperosmolar state (HHS) by administering intravenous fluids, insulin, and electrolytes (**Fig. 16.1**) and by closely monitoring during treatment, ensuring timely and bridged transition to maintenance subcutaneous insulin administration, and identifying and treating the precipitating cause. **A**

16.15 The discharge planning process should include education on the recognition, prevention, and management of DKA and/or HHS for all individuals affected by or at high risk for these events to prevent recurrence and readmission. **B**

There is considerable variability in the presentation of DKA and HHS, including euglycemic DKA (defined as plasma glucose levels <200 mg/dL [<11.1 mmol/L] in the presence of ketosis and metabolic acidosis), mild to moderate hyperglycemia and acidosis, or severe hyperglycemia, dehydration, and coma; therefore, individualization of treatment based on a careful clinical and laboratory assessment is needed (70,73,133,134).

Management goals include restoration of circulatory volume and tissue perfusion, resolution of ketoacidosis, and correction of electrolyte imbalance and acidosis. It is also essential to treat any correctable underlying cause of DKA, such as sepsis, myocardial infarction, or stroke. In critically ill and mentally obtunded individuals with DKA or HHS, continuous intravenous insulin is the standard of care. Successful transition from intravenous to subcutaneous insulin requires administration of basal insulin 2–4 h before the intravenous insulin is stopped to prevent recurrence of ketoacidosis and rebound hyperglycemia while the subcutaneous insulin action rises (71,133,135). Studies have reported that the administration of a low dose of basal insulin analog in addition to intravenous insulin infusion may prevent rebound hyperglycemia without increased risk of hypoglycemia (72–74,133). There is no significant difference in outcomes for intravenous human regular insulin versus subcutaneous rapid-acting analogs when combined with aggressive fluid management for treating mild or moderate DKA (136). Individuals with uncomplicated DKA may sometimes be treated with subcutaneous rapid-acting insulin analogs in the emergency department or step-down units (137). This approach may be safer and more cost-effective than treatment with intravenous insulin. If subcutaneous insulin administration is used, it is important to provide an adequate fluid replacement, frequent POC blood glucose monitoring, treatment of any concurrent infections, and appropriate follow-up to avoid recurrent DKA. Several studies have shown that the use of bicarbonate in people with DKA made no difference in the resolution of acidosis or time to discharge, and its use is generally not recommended (138). For further treatment information and in-depth review, refer to the recently updated ADA consensus report (70).

TRANSITION FROM THE HOSPITAL TO THE AMBULATORY SETTING

Recommendation

16.16 A structured discharge plan should be tailored to the individual with diabetes. **B**

A structured discharge plan tailored to the individual may reduce the length of hospital stay and readmission rates and increase satisfaction with the hospital experience (139,140). Multiple strategies are key, including diabetes self-management education prior to discharge, diabetes medication reconciliation with attention to access, and scheduled virtual

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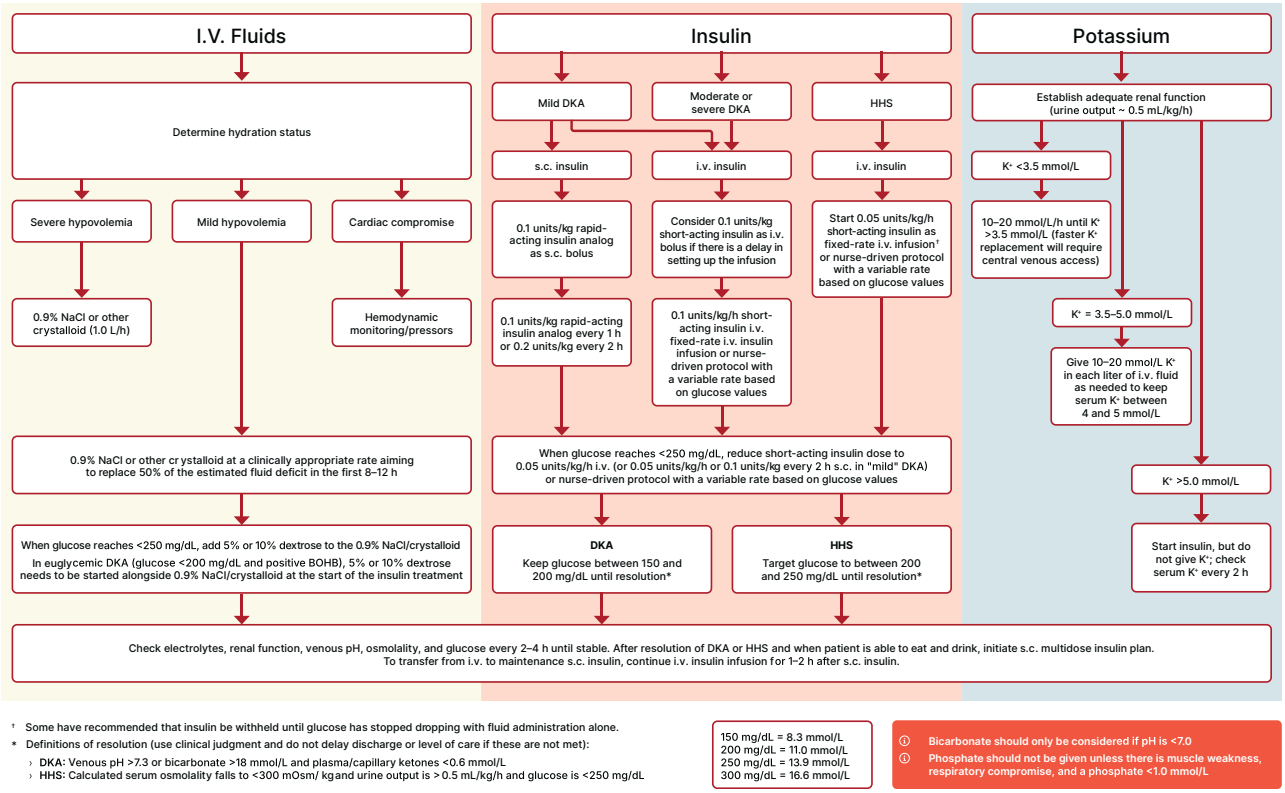
I.V. Fluids
Determine hydration status
Severe hypovolemia
Mild hypovolemia
Cardiac compromise
0.9% NaCl or other crystalloid (1.0 L/h)
Hemodynamic monitoring/pressors
0.9% NaCl or other crystalloid at a clinically appropriate rate aiming to replace 50% of the estimated fluid deficit in the first 8–12 h
When glucose reaches <250 mg/dL, add 5% or 10% dextrose to the 0.9% NaCl/crystalloid
In euglycemic DKA (glucose <200 mg/dL and positive BOHB), 5% or 10% dextrose needs to be started alongside 0.9% NaCl/crystalloid at the start of the insulin treatment
Insulin
Mild DKA
Moderate or severe DKA
HHS
s.c. insulin
i.v. insulin
i.v. insulin
0.1 units/kg rapid-acting insulin analog as s.c. bolus
Consider 0.1 units/kg short-acting insulin as i.v. bolus if there is a delay in setting up the infusion
Start 0.05 units/kg/h short-acting insulin as fixed-rate i.v. infusion† or nurse-driven protocol with a variable rate based on glucose values
0.1 units/kg rapid-acting insulin analog every 1 h or 0.2 units/kg every 2 h
0.1 units/kg/h short-acting insulin i.v. fixed-rate i.v. insulin infusion or nurse-driven protocol with a variable rate based on glucose values
When glucose reaches <250 mg/dL, reduce short-acting insulin dose to 0.05 units/kg/h i.v. (or 0.05 units/kg/h or 0.1 units/kg every 2 h s.c. in "mild" DKA) or nurse-driven protocol with a variable rate based on glucose values
DKA
Keep glucose between 150 and 200 mg/dL until resolution*
HHS
Target glucose to between 200 and 250 mg/dL until resolution*
Potassium
Establish adequate renal function (urine output ~ 0.5 mL/kg/h)
K+ <3.5 mmol/L
10–20 mmol/L/h until K+ >3.5 mmol/L (faster K+ replacement will require central venous access)
K+ = 3.5–5.0 mmol/L
Give 10–20 mmol/L K+ in each liter of i.v. fluid as needed to keep serum K+ between 4 and 5 mmol/L
K+ >5.0 mmol/L
Start insulin, but do not give K+; check serum K+ every 2 h
Check electrolytes, renal function, venous pH, osmolality, and glucose every 2–4 h until stable. After resolution of DKA or HHS and when patient is able to eat and drink, initiate s.c. multidose insulin plan.
To transfer from i.v. to maintenance s.c. insulin, continue i.v. insulin infusion for 1–2 h after s.c. insulin.
† Some have recommended that insulin be withheld until glucose has stopped dropping with fluid administration alone.
* Definitions of resolution (use clinical judgment and do not delay discharge or level of care if these are not met):
› DKA: Venous pH >7.3 or bicarbonate >18 mmol/L and plasma/capillary ketones <0.6 mmol/L
› HHS: Calculated serum osmolality falls to <300 mOsm/ kg and urine output is >0.5 mL/kg/h and glucose is <250 mg/dL
150 mg/dL = 8.3 mmol/L
200 mg/dL = 11.0 mmol/L
250 mg/dL = 13.9 mmol/L
300 mg/dL = 16.6 mmol/L
Bicarbonate should only be considered if pH is <7.0
Phosphate should not be given unless there is muscle weakness, respiratory compromise, and a phosphate <1.0 mmol/L

Figure 16.1—Treatment pathways for diabetic ketoacidosis (DKA) and hyperglycemic hyperosmolar state (HHS). BOHB, β-hydroxybutyrate. Adapted from Umpierrez et al. (70).

and/or face-to-face follow-up visits after discharge. Discharge planning should begin at admission and be updated as individual needs change (141,142). Individualization and shared decision-making is key when creating a safe and effective discharge plan.

The transition from the acute care setting presents risks for all people with diabetes. Individuals may be discharged to varied settings, including home (with or without visiting nurse services), assisted living, rehabilitation, or skilled nursing facilities. For individuals discharged to home or assisted living, the optimal discharge plan will need to consider diabetes type and severity, effects of the illness on blood glucose levels, and the individual's circumstances, capabilities, and preferences (19,143,144). See Section 13, "Older Adults," for more information.

An outpatient follow-up visit with primary care, endocrinology, or a diabetes care and education specialist within 1 month of discharge is advised for all individuals experiencing hyperglycemia and/or hypoglycemia in the hospital. If glycemic management medications are changed or glucose management is not optimal at discharge, an earlier appointment (in 1–2 weeks) is preferred, and frequent contact to consider therapy adjustments may be needed to avoid hyperglycemia and hypoglycemia. A discharge algorithm for glycemic medication adjustment, based on admission A1C, diabetes medications before admission, and insulin usage during hospitalization was found useful to guide treatment decisions and significantly improve A1C after discharge (4).

Clear communication with outpatient health care professionals directly or via hospital discharge summaries facilitates safe transitions to outpatient care. Providing information regarding the root cause of hyperglycemia (or the plan for determining the cause), related complications and comorbidities, and recommended treatments can assist outpatient health care professionals as they assume ongoing care.

The Agency for Healthcare Research and Quality recommends that, at a minimum, discharge plans include the following (145):

Medication Reconciliation

- Home and hospital medications must be cross-checked to ensure that no chronic medications are stopped and to ensure the safety of new and old prescriptions.
- Prescriptions for new or changed medication should be filled and reviewed with the individual and care partners at or before discharge whenever possible.

Structured Discharge Communication

- Information on medication changes, pending tests and studies, and follow-up needs must be accurately and promptly communicated to outpatient health care professionals.
- Discharge summaries should be transmitted to the primary care health care professional as soon as possible after discharge.
- Scheduling follow-up appointments prior to discharge with people with diabetes agreeing to the time and place increases the likelihood that they will attend.

It is recommended that the following areas of knowledge be reviewed and addressed before hospital discharge:

- Identification of the health care professionals who will provide diabetes care after discharge.

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- Level of understanding related to the diabetes diagnosis, glucose monitoring, home glucose goals, and when to call a health care professional.
- Definition, recognition, treatment, and prevention of hyperglycemia and hypoglycemia.
- Information on choosing healthy food at home and referral to an outpatient registered dietitian nutritionist or diabetes care and education specialist to guide individualization of the meal plan, if needed.
- When and how to take blood glucose-lowering medications, including insulin administration and noninsulin injectables.
- Sick-day management (19,144).
- Proper use and disposal of diabetes supplies, e.g., insulin pens, pen needles, syringes, glucose meters, and lancets.

People with diabetes must be provided with appropriate durable medical equipment, medications, supplies (e.g., blood glucose test strips or CGM sensors), prescriptions, and appropriate education at the time of discharge to avoid a potentially dangerous hiatus in care.

PREVENTING ADMISSIONS AND READMISSIONS

In people with diabetes, the hospital readmission rate is between 14% and 20%, which is nearly twice that in people without diabetes (141,146). This may result in increased diabetes distress and has significant financial implications. Of people with diabetes who are hospitalized, 30% have two or more hospital stays, and these admissions account for over 50% of hospital costs for diabetes (147). Factors contributing to readmission include male sex, longer duration of prior hospitalization, number of previous hospitalizations, number and severity of comorbidities, and lower socioeconomic and/or educational status; factors that may reduce readmission rates include scheduled home health visits and timely ambulatory follow-up care (141,146). While there is no standardized protocol to prevent readmissions, several successful strategies have been reported that identify high-risk individuals and offer some possible solutions (141). To prevent readmissions, monitor insulin adjustments for individuals admitted with A1C >9% (>75 mmol/mol) (148) or DKA (149,150) and follow a transitional care model (151). For individuals hospitalized with severe hypoglycemia, impaired awareness of hypoglycemia, or high risk for hypoglycemia (end-stage kidney disease, intensive insulin management, frailty, etc.), consider prescribing glucagon to treat any future severe hypoglycemia events (152,153). For people with diabetes and chronic kidney disease, collaborative person-centered medical homes may decrease risk-adjusted readmission rates (154). Since recent studies have shown that use of CGM may prevent emergency department visits and hospital admission in people with type 1 and type 2 diabetes, it may be beneficial to initiate CGM just prior to discharge to facilitate follow-up and possibly prevent acute diabetes-related complications and readmission (155).

Age is also an important risk factor in hospitalization and readmission among people with diabetes (refer to Section 13, "Older Adults," for detailed criteria). Successful proactive care transitions from inpatient to outpatient is a key strategy for preventing readmission and emergency department visits.

THE FUTURE

Inpatient diabetes management is challenging for hospitals, health care professionals, and people with diabetes, as acute illness increases the risk of both hypoglycemia and hyperglycemia. The use of decision support tools and best practice advisories in the EHR has facilitated health care professionals following the recommendations in this standard of care. In addition, personal and hospital-owned diabetes devices and dosing algorithms are changing the way we provide care. Future enhancements will likely continue to improve the quality of care we deliver in hospitals and in transitions from inpatient to outpatient.

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